UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION 4

61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

September 24, 2020

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MEMORANDUM - DRAFT

SUBJECT: Review of the Supplemental Corrective Measures Study 2017 Letter Report and Ecological Risk Evaluation for the International Paper Site in Wiggins, MS

FROM: Brett Thomas, Ph.D., Life Scientist
Scientific Support Section
Superfund & Emergency Management Division
Superfund Resource and Scientific Integrity Branch

THRU: Tim Frederick, Chief, Scientific Support Section

TO: Maher Budeir, Corrective Action Specialist, Land, Chemicals and Redevelopment Division

Per your request, I have reviewed the "Supplemental Corrective Measures Study – 2016" Letter Report dated February 21, 2017, including the "Ecological Risk Assessment Screening" report included as Attachment B to the Letter Report, for the International Paper site in Wiggins, Mississippi. The purpose of the review was to determine if the surface water and sediment sampling and assessment had answered the remaining ecological risk assessment concerns identified when site investigation was being performed in 2015 – 2016. Due to the amount of time that has passed since we were actively working on this site, I am not completely familiar with all of the issues that were to be addressed by this Letter Report. I used the information from my previous memos for the site (in 2015 and 2016) to get an idea of what the key issues to be addressed were, and reviewed the Letter Report and the attached ERA to determine if the issues had been significantly addressed. It appears from my 2016 memo that copper in Church House Branch (CHB) surface water at SW-2 and dioxins/furans in CHB sediments were the primary outstanding issues, and these were both addressed in this Letter Report. Each issue will be discussed separately below, but in summary, copper in surface water does not appear to be a further concern, but dioxins/furans in sediment do appear to potentially pose risks to ecological receptors in Church House Branch.

Surface Water and Copper

Previous sampling had shown that the surface water in Church House Branch at SW-2 contained copper at concentrations of concern and more sampling was requested to determine if this was more than just an anomalous occurrence and if so, what the source of the copper might be. The Letter Report in Section I.A states that samples were taken at locations SW-1.5, SW-2, and SW-2.5. The locations are reportedly shown on Figure 1, but I do not see SW-1.5 or SW-2.5 marked on the map. I am guessing that they are upstream and downstream, respectively, of SW-2. The copper concentrations reported for these samples are below the chronic water quality criteria for copper, so it is not believed that elevated copper is likely to be a regular occurrence in the creek and therefore not likely to pose appreciable risks to ecological receptors. It is not believed that more surface water sampling or investigation is warranted for copper in surface water at this time.

Sediments and Dioxins/Furans

Elevated dioxin concentrations had been reported for sediments in Church House Branch (CHB), so further sampling of CHB sediments was requested. IP had samples taken at sample locations SD-1, SD-3, SD-5, SD-6, and SD-7. The results as TCDD-TEQs (dioxin-equivalent concentrations) for mammals are presented in Table 3 (P. 12/103) in the letter, and are listed for convenience in Table A below.

Table A. Dioxin/furan concentrations as TCDD-TEQs for the Church House Branch sediment samples taken in June 2016.

Sample location	SD-1	SD-3	SD-5	SD-6	SD-7
Mammal TCDD-TEQ, ng/kg	5.8 (mostly ND)	5690	2350	2410	1120
TOC, mg/kg	4540	5190	24400	25000	8050

The reference location (SD-1), upstream of the site's influence on CHB, has low (~6 ng/kg) TCDD-TEQ, but the four site-affected CHB locations have high TCDD-TEQs. For reference, the screening values for TCDD-TEQ in sediments range from lows of 0.5 – 2.5 ng/kg to highs of 2.2 – 25 ng/kg. The Letter Report states that because the dioxin/furan results were elevated, an Ecological Risk Evaluation of the dioxin risks was performed and is attached to the Letter Report as Attachment B, and this is reviewed below.

Ecological Risk Evaluation Report, Ramboll Environ, Attachment B, Feb 2017 (starts on pdf P. 15/103)

Section 4,3,2, P. 28/103 and Tables 4-2, P. 42-48/103: In looking through the calculations performed by Ramboll, it appears that they calculated a dioxin/furan concentration in fish or insect tissue using the equations from the reference they gave, EPA 2008. The equations they present on P. 28/103 and P. 7 of Tables 4-2 are functionally the same equations as in the

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reference, except on P. 28/103 they note that the "$C_{\text{fish or invert}}$", or the fish or invertebrate dioxin/furan tissue concentration, is in dry weight tissue, rather than "fresh" weight or wet weight. In the EPA 2008 reference, an excerpt of which is below, the text states that the equation as given calculates a TEC, or Toxic Equivalent Concentration, in the tissue in wet weight; the bolding below is mine:

> From EPA 2008, Section 3.3.1.4, P. 33:
>
> "While TEFs-$WHO_{98/05}$ (or RPFs/RePs) cannot be used to calculate TECs directly from concentrations of PCDDs, PCDFs, and PCBs in water or sediments, they may be combined with BAFs or BSAFs and the fraction lipid in the organism (f_λ) to determine a **wet weight** TEC for an organism as shown in the following two equations [*equation 3-3 not shown*]:
>
> $$\text{TEC} = \sum_{n=1}^{k} (C_{\text{sed org carbon}})_n\, (\text{BSAF})_n\, (f_\lambda)(\text{TEF}_n) \qquad \text{equation 3-4 "}$$

This is equivalent to the equation used by Ramboll of

$$C_{\text{fish or invert}} = C_{\text{sediment}} / f_{\text{org carbon}} \ \text{x BSAF x}\ f_{\text{lipid}}$$

except then for the Ramboll equation the $C_{\text{fish or invert}}$ value would be multiplied by the TEF for that congener to result in a TEC for that congener, then this would be done for all of the congeners in the sample, and then all of the individual TECs would be added together to obtain the TCDD-TEQ or sum TCDD-TEC for the sample, which is what equation 3-4 from EPA 2008 does.

The point is that the $C_{\text{fish or invert}}$ values calculated with the above equation and using the BSAF values from EPA 2008, which Ramboll does, are in wet weight, according to the reference. It appears in Table 4-2 in the Ecological Risk Evaluation that Ramboll calculated the C_{fish} or C_{invert} values and assumed they were dry weight, so then multiplied the C_{fish} or C_{invert} by the decimal percent solids, for example times 0.29 for the fish which was assumed to be 71% moisture, to obtain a wet weight tissue concentration of dioxin/furan. It looks like the conversion to wet weight was not necessary, and would have the effect of making the estimated tissue dioxin/furan concentrations 70-80% smaller than they should have been. This obviously will have some effect on the dose estimates and thus risk estimates in the food chain model.

Section 4.5, Total Daily Intake: The TDI equation should have the sed ingestion rate (IR_{sediment}) as dry weight sediment, not "fresh weight" sediment, I believe.

Table 4-3, P. 49/103, Receptor Parameters (also discussed in Section 4.4, P. 30/103):

- Green Heron: The Food Ingestion Rate (FIR) that Ramboll uses equates to 0.27 kg wet wt food/kg BW-d, and I believe that this FIR is too low. The value I use is 0.6 kg food/kg BW-d, which is interpreted from an ornithology website. The other parameters they have for the green heron are acceptable.

- Raccoon: The parameters I use for the Raccoon are a little different than what Ramboll uses. I use a FIR of 0.249 kg ww/kg BW-d, a soil/sediment ingestion rate of 9.4% of FIR, and a home range of 52 ha.
- Marsh Rice Rat: Ramboll assumes the rats eat 70% vegetation, but information I found (Kruchek 2004) indicates that the rat prefers invertebrates to vegetation when given the opportunity, and provides data that shows the diet to be approximately 75% aquatic invertebrates and 25% aquatic vegetation. For the FIR, I used the Nagy equation in the WEFH (equation 3-8 in Section 3.1.2, P. 3-6, P. 506/572), a body weight of 0.051 kg from the Ramboll report*, and a food moisture content of 79% from the Ramboll report to calculate a FIR of 0.56 kg wet wt food/kg BW-d. For soil/sediment ingestion rate, Beyer in WEFH estimated <2% for the white-footed mouse and 2.4% for the meadow vole, so I estimate 2% for the Marsh Rice Rat.

Ecological Risk Estimates Calculated as Part of This Review

Because I believe that a procedural error was made in the risk calculations (regarding the dry-to-wet weight conversion described above) and because I differ with Ramboll as far as some of the Exposure Parameters for the receptors we are assessing, I believed it would be worth the time as part of this review to calculate independent risk estimates for the three receptors from the dioxins/furans measured in the sediments of CHB. Using the data presented in the Supplemental CMS Letter Report Table 2, and the equations and approach described in EPA 1999 (for plant tissues) and EPA 2008 (for invertebrate and fish tissues), generally similar to what Ramboll did, I calculated the Toxicity Equivalence Concentrations (TECs) for the sediments and prey item tissues. The results are presented below in Table B. Additionally, other parameters used in the food chain model risk calculations are also presented in Table B.

Table B. Key Parameters and other information to use in the food chain models:

	Plants	inverts	fish	
Percent solids (1 - % moisture)	26%	21%	29%	
% lipids (kg lipid/kg organism body weight)	NA	1.6% (0.016)	5% (0.05)	
Measured or calculated parameter	SD-3	SD-5	SD-6	SD-7
kg organic carbon/kg sed	0.00519	0.0244	0.025	0.00805
TCDD-TEC in sed – mammal, ng/kg	5688	2347	2405	1126
TCDD-TEC in sed – bird, ng/kg	2762	1149	1233	571
TCDD-TEC in plant tissue, ng/kg WW for mammal	1.73	0.73	0.77	0.34
TCDD-TEC in invert tissue, ng/kg WW for mammal	616.2	54	55	76
TCDD-TEC in invert tissue, ng/kg WW for bird	1106.2	73	74	104

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TCDD-TEC in fish tissue, ng/kg WW for mammal	1926	167	173	237
TCDD-TEC in fish tissue, ng/kg WW for bird	3457	228	232	325
Receptor	FIR, kg WW/kg BW-d	SIR, % of DW FIR	Home Range, acres	Diet
Green Heron	0.6	2%	11 (AUF=1)	100% Fish
Marsh Rice Rat	0.56	2%	0.6** (AUF=1)	25% plant, 75% inverts
Raccoon	0.249	9.4%	128 (AUF≈0.4)	25% plant, 75% inverts
	NOAEL	LOAEL		
Mammal TRV, ng TCDD/kg BW-d	1	10		
Avian TRV, ng TCDD/kg BW-d	14	64		

Note: The site size as reported by Ramboll is 20 acres, though not all of the contamination had been delineated, as contamination was still found at the furthest downstream sampling location, SD-7, so there may be elevated dioxin/furan concentrations in the sediments downstream of the delineated area.

The sediment TCDD-TECs I calculated and reported in Table B above ended up the same as what Ramboll calculated (Ramboll report Attachment B, Table 4-1), as did the plant tissue TCDD-TECs (Attachment B, Table 4-2; based on EPA 1999). The TCDD-TECs for invertebrate and fish tissues I calculated and reported in Table B were different (higher) however. This is likely due to the following reasons:

- Ramboll used an average organic carbon (OC) concentration in sediment of 15,560 mg OC/kg sediment (Attachment B, Table 4-2 footnotes, P. 48/103) in their calculations, which I assume is the average of the five sediment samples taken from CHB. I used the organic carbon concentration in sediment for each individual sample to calculate the uptake at each individual sample location, since I believed that was a more accurate estimation of potential bioaccumulation from the sediments at each location.
- For the f_{oc}, or fraction of organic carbon in the sediments, Ramboll used a f_{oc} value of 0.156 to correspond to their average of 15,560 mg/kg, representing 15.6% organic carbon by weight. I do not believe this conversion is correct, however. For a value of 15,560 mg/kg, or parts per million, this would be 15.56 g/kg, or parts per thousand. For percent, or parts per hundred, this would then be 1.556 parts per hundred, or 1.556%. This would then give a fraction by weight, or f_{oc} , of 0.0156, rather than 0.156. So if my

interpretation is correct, this issue itself would have made the Ramboll TCDD-TEC estimates 10 times smaller than they actually would have been.

- As described above, after calculating the $C_{\text{fish or invert}}$ values using the equation and BSAFs from EPA 2008, Ramboll multiplied the $C_{\text{fish or invert}}$ values by the percent solids value in order to convert dry weight concentration to wet weight concentration. And as described, my interpretation of EPA 2008 methodology is that the $C_{\text{fish or invert}}$ value is already in wet weight tissue, so that the percent solids multiplier would erroneously reduce the TCDD-TEC estimates in fish or invertebrate tissues by roughly 70%-80%.

The information and results in Table B were used in simple food chain model calculations to obtain the estimated doses of TCDD-TECs to the green heron, marsh rice rat and raccoon, and then these estimated doses, and the Toxicity Reference Values (TRVs) in Table B, were used to estimate No Observed Adverse Effect Level (NOAEL) based and Lowest Observed Adverse Effect Level (LOAEL) based risks to these receptors. The estimated risks are reported below in Table C.

Table C. Risk estimates from the food chain models based upon the inputs from Tables A and B (above).

Receptor	TRV type	Hazard Quotient			% of dose via food ingestion (the rest is via sediment ingestion)
		SD-3	SD-5/SD-6	SD-7	
Green Heron	NOAEL	149	10	14	97%-99% (only fish)
	LOAEL	33	2	3	
Marsh Rice Rat	NOAEL	20	2	2	85%-96% for inverts; 5%-6% for vegetation
	LOAEL	4	0.5	0.5	
Raccoon (AUF = 0.4)	NOAEL	4	0.6	0.6	54%-85% for inverts; 1%-2% for vegetation
	LOAEL	0.9	0.1	0.1	

The risk estimates I calculated and report in Table C are higher than those that Ramboll calculated especially for SD-3 partly because I used modestly different exposure factors as mentioned for a few of the parameters (would probably account for roughly a 2X difference), but primarily because of the other three issues I described above. The NOAEL HQs in Table C are greyed out because we would likely not protect non-special status species at a NOAEL-based level of protection, in most cases, but they are included for completeness. For the LOAEL-based HQs, the issue of primary concern is for piscivorous birds like the green heron (or other piscivorous animals) around the sampling location SD-3. Sampling location SD-7 has some elevated risks, but SD-3 is of primary concern. As shown in the far right column, almost all of the TCDD-TEC dose for the heron is estimated to come from ingestion of fish. Part of what drives the high estimate of TCDD-TEC in the fish tissue is the relatively low amount of organic carbon in the SD-3 sediment, as this would in theory cause the dioxins/furans in the sediments to be more likely to partition into the fish tissues. Actually collecting and measuring forage fish tissue TCDD-TECs from this area of the creek would be helpful in reducing the uncertainty around this risk estimate. The marsh rice rat has a somewhat elevated LOAEL HQ at SD-3 as well, with 95% of its estimated dose coming via invertebrate ingestion. Collecting and analyzing invertebrate tissue to measure the TCDD-TECs would also help to reduce the uncertainty around this risk estimate as well.

There are several aspects of uncertainty around the extent of contamination in this area of Church House Branch. Since the channel is braided, it may be that other "braids" of the creek have less (or more) dioxin/furan contamination than the main channel that was sampled. Additionally, elevated dioxin/furan was measured in the sediments at SD-7, which is the furthest downstream sample location. This indicates that there could be additional contamination in the creek downstream of SD-7, although the relatively low HQs at SD-7 indicate that the contamination below SD-7 is less likely to pose appreciable risks.

It can be argued that the risk estimates should be averaged across the three sampling locations (SD-3, SD-5/6, SD-7) across the reach of CHB sampled, rather than considered by individual location. A counter to averaging in this case however is that each sample represents a fairly large area of good quality habitat. From the information in Figures 3-1 and 4-1 of Attachment B, assuming the orange rectangle area in Figure 4-1 is roughly 20 acres (as is stated on the Figure) and assuming the contamination entered the creek from Ditch 4, the potential area represented by SD-3 and its level of contamination might be around 7 or so acres. I verified this by using Google Earth to map out the potential area of contamination, and the area I estimated was roughly 6-7 acres. That is an appreciably large area to have that level of dioxin/furan contamination, given the risk estimates I calculated. Unfortunately, the area also appears to contain a ponded surface water feature, as can be seen in Figure A (at the end of this memo). I had seen a ponded area when at the site years ago, and Ramboll included pictures of a ponded area in their report, though they indicate the ponded area in their photos is upstream of SD-2 and therefore upstream of the Ditch 4 outfall location. Google Earth aerial photos indicate that at times there is a ponded area upstream of the site, but it looks to be sporadic when viewing pictures progressing back in time (perhaps present only during wetter seasons or perhaps due to inconsistent beaver damming activity). The ponded area upstream of the site does not appear to be present in the wider range aerial photo (the most recent Google Earth photo) from which Figure A was taken. The ponded area just downstream of SD-3 is clearly visible in the aerial picture of Figure A, and the historic Google Earth photos show its presence consistently. The presence of a large ponded water feature downstream of SD-3, if it is in the creek flowpath that carried the dioxins, would likely pose a much more significant ecological exposure risk than small braided creek channels might. And it would be expected that if the main channel flows into the pond, the ponded feature would be contaminated throughout most of its extent, as fairly high concentrations of dioxins/furans were found at SD-5/6 and SD-7, downstream of the ponded area. Additionally, given the magnitude of the heron HQ I calculated, it would imply that receptors would not necessarily have to spend very long in the contaminated area to obtain a dose of dioxins/furans that could cause adverse effects. Given all of these considerations, I believe that averaging HQs across the entire sampled reach of CHB would not be appropriate in this instance, and considering the area around SD-3 and potentially the pond downstream of it as a discrete exposure area would be warranted.

Recommendations for Further Assessment/Risk Estimate Refinement

Considering the risk estimates around location SD-3, I would recommend considering the following actions for refining the risk estimates:

- Additional sediment sampling in Church House Branch between Ditch 4 outfall and SD-5 to better delineate the extent of dioxin/furan contamination in the sediments, in the creek and also in the ponded area
- Collection of fish and invertebrates (and plants?) from the creek/pond area between Ditch 4 outfall and SD-5 to measure the dioxin contamination in the tissues, to provide better data for use in the risk calculations
- Also potentially consider collecting information from the Ditch 4 to SD-5 stretch of the creek that could be used to assess the potential for natural attenuation/recovery regarding the dioxin contamination

Thank you for the opportunity to review this document. If you have questions or would like to discuss these comments, please contact me at (404) 562-8751 or at Thomas.Brett@epa.gov.

Brett Thomas

References

EPA 2008. Framework for the Application of the Toxicity Equivalence Methodology for Polychlorinated Dioxins, Furans, and Biphenyls in Ecological Risk Assessment. EPA/100/R-08/004.

Kruchek, B. 2004. Use of Tidal Marsh and Upland Habitats by the Marsh Rice Rat (*Oryzomys palustris*). *Journal of Mammalogy*, Volume 85, Issue 3, June 2004, Pages 569–575.

* Marsh Rice Rat body weight: The reference for body weight for the Marsh Rice Rat in the Ramboll 2017 Ecological Risk Evaluation for CHB report is: Davis, W.B., and D.J. Schmidly, 1994. The Mammals of Texas: Online Edition. Accessed at http://www.nsrl.ttu.edu/tmot1/Default.htm

** The reference for the Marsh Rice Rat home range size of 0.25 hectares for males and 0.33 ha for females is : Birkenholz, D.E. 1963. Movement and displacement in the rice rat. Quarterly Journal Florida Academy of Sciences 26:269-274 . As cited in USFWS document “Rice Rat: Multi-species Recovery Plan for South Florida”, found at: https://www.fws.gov/verobeach/MSRPPDFs/RiceRat.pdf

Figure A. Church House Branch sediment sampling locations and ditch outfall locations.

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